SYSTEM FOR DISPLAYING IMAGES FROM MULTIPLE PROJECTORS ONTO A COMMON SCREEN

TECHNICAL FIELD

The present invention relates generally to projection display systems and, more particularly, to a projection display system employing multiple projectors and a common display screen.

BACKGROUND OF THE INVENTION

The quality of an image on the display screen of a standard projection display diminishes significantly as the performance limits of the projection display are approached or exceeded. For example, the brightness of the image on the display screen is a function of the output of the projector light source and the size of the image on the display screen. Since the brightness of the image decreases as the image size increases, the brightness of the image may become unacceptably low if a relatively large image is projected onto an oversize display screen using a projector light source having an insufficient output. The resolution of the image on the display screen is a function of the resolution of the image source used in the projector of the projection display, but is independent of the size of the image on the display screen. The resolution of the image source, and correspondingly the resolution of the image on the display screen, is defined by the number of pixels provided in the horizontal and vertical direction. Conventional projection displays for displaying computer information typically have resolutions of 640 by 480, 800 by 600, or 1024 by 768, which correspond to an aspect ratio of 4:3. However, many projection display applications require the projection of higher resolution images or images having alternate aspect ratios onto the display screen.

A current challenge is to develop cost effective projection displays capable of producing images for viewing on display screens, which have relatively high resolution or which have a non-standard aspect ratio. For example, air traffic control applications can require a projection display for radar images having a high resolution of 2000 by 2000. Avionics applications can require a small panoramic projection display having a higher than conventional resolution and a wider aspect ratio. Medical imaging applications can require a projection display having a significantly higher than conventional resolution and a very high contrast. High definition television applications require a projection display having a resolution of 1700 by 1000 at a 9:16 aspect ratio for full performance. Although projection displays utilizing a single projector have been demonstrated, which exhibit the required resolutions and aspect ratios for the above-recited applications, such displays must typically be custom produced because of the limited demand for projection displays satisfying specific high-end performance requirements. As a result, the cost of high resolution projection displays is oftentimes prohibitively high relative to the cost of conventional lower resolution projection displays.

One approach to solving the problem of high cost with respect to high resolution projection displays is described with reference to FIG. **1**, wherein a projection display system generally designated **10** is shown. The projection display system **10** utilizes two conventionally-sized on-axis projectors **12, 14** positioned in parallel behind a single large display screen **16**. An on-axis projector is characterized by the coalignment of the projector axis and the axis of the image projected therefrom. Each of the on-axis projectors **12, 14** has a Fresnel lens **18, 20**, associated with the projector. The Fresnel lenses **18, 20** are positioned side-by-side behind the screen **16** and are aligned with the images **22, 24** emanating from the on-axis projectors **12, 14**, respectively. The on-axis projectors **12, 14** operate in cooperation with one another to project the two images **22, 24** side-by-side onto the screen **16** so that the two images **22, 24** appear to the viewer as a single large image having twice the size of the two smaller images **22, 24**.

Producing an apparent single large image of acceptable quality by tiling two smaller side-by-side images together has proven to be problematic, however, because distortion creates a seam down the center of the apparent large image where the two smaller images **22, 24** interface. Distortion along the central seam of the image is attributable in part to brightness non-uniformities which are inherent to projection display systems. In the case of a system employing a single rear projector and a Fresnel lens which projects a nominally collimated image onto a screen, light from the on-screen image which is received by the eye of a viewer at an angle of 90° appears brighter to the viewer than light from the on-screen image which is received by the viewer at an angle other than 90°. Consequently the on-screen image has a brightness "hot spot" corresponding to the position of the viewer relative to the screen. To combat this effect, conventional projection display systems focus the on-screen image toward a position an optimum design distance from the screen where an idealized viewer is located. Light from all areas of the screen is directed to the viewer at this position, improving brightness uniformity. Even with this design, however, brightness falls off at a cosine function due to projection optics and the reduced efficiency of the Fresnel lens toward the edge of the lens.

The projection display system **10** of FIG. **1**, which employs two on-axis projectors **12, 14**, is particularly susceptible to brightness non-uniformities because the edge of the image exiting each of the Fresnel lenses **18, 20** is aligned with the center axis **26** of the screen **16**. As a result, the on-screen image of the system **10** displayed to the viewer is least bright at the center of the screen **16**, rather than more desirably at the edge of the screen, as in the case of a single projector system. The twin on-axis projector configuration of the system **10** also causes the brightness on one half of the screen **16** to drop off faster than the brightness on the other half of the screen **16** as the viewer moves to either side of the center axis **26**. It is further noted that the image exiting each of the Fresnel lenses **18, 20** must be divergent with some distance to the screen **16** to permit alignment of the side-by-side images on the screen **16** without creating a space between them.

Distortion of the image along its central seam may also be attributable to difficulties in providing accurate geometrical alignment of the projected images with their respective Fresnel lenses **18, 20**. Inaccuracies in geometrical alignment of the projected images with the Fresnel lenses **18, 20** produce unacceptable artifacts and a loss of pixel information at the seam. A large stable mechanical supporting structure is required to provide stable and accurate geometrical alignment of the images at the seam. However, such structures are impractical from both a size and cost standpoint.

It is apparent that a need exists for a projection display system that overcomes the above-recited problems inherent to tiled projection display systems. Accordingly, it is an object of the present invention to provide an effective tiled projection display system. In particular, it is an object of the present invention to provide a projection display system that